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PERFORMANCE AND CHARACTERISTICS OF THE CASSIOPÉE SYSTEM

TRANSLATION OF: Performances et Caractéristiques du Système CASSIOPÉE. Société d'Applications Générales d'Électricité et de Mécanique (S.A.G.E.M.) and Compagnie des Compteurs (C.d.C.), Paris, 1965, 5p.

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New Tool Available to Researchers 1/

On 15 October 1968 a TACITE sounding rocket carrying two scientific experiments was successfully launched from the Test Center at Île du Levant. It reached an altitude of 150 km during its 9-minute flight. The operation of the CASSIOPÉE device during the climbing phase of the flight was in accordance with previous estimates. This first launch of a French high-precision guidance system is a success which opens the way to important astronomical research programs using sounding rockets.

Many physical experiments and observations carried out on the 2/ ground are impeded by the presence of the atmosphere. This is especially true for all phases of the study of all emitting sources in the heavens.

It is therefore necessary to replace these terrestrial observations systems by a system that has been launched into space and is guided automatically.

The realization of such a system has been made possible by the extensive experience gained by French study organizations and industries in space technology: manned aircraft, guided missiles, satellites, etc.

It was necessary, in effect, to design a system which would ensure the required precision under the extremely severe environmental conditions encountered by sounding rockets.

The CASSIOPÉE system (Contrôle d'Altitude par Senseurs Stellaires et Inertiels pour l'Orientation et le Pointage d'Expériences sur les Étoiles = Attitude Control by Stellar and Inertial Sensors for the Orientation and Guidance of Experiments on Stars) studied by the O.N.E.R.A. (Office National d'Études et Recherches Aérospatiales = National Bureau for Aerospace Studies and Research) and C.d.C. (Compagnie des Compteurs) for the C.N.E.S. (Centre National d'Études Spatiales = National Center

for Space Studies) and built by S.A.G.E.M. (Societe d'Applications Générales d' Électricité et de Mécanique) not only fulfills these two requirements but is also characterized by a flexibility of application that makes it possible to aim at several objectives in succession and even to explore their immediate surroundings.

Likewise, it is available in several versions which allow system performance to be matched to the customer's requirements.

The CASSIOPÉE System 3/

Purpose

The CASSIOPÉE system is mounted between the nose cone of a rocket and the propulsion system, and makes it possible (after separation of these two elements) to stop the rotation of the nose cone on its axis, to orient the latter in any previously determined direction in space, and to maintain this orientation during the entire flight with an accuracy of one minute of arc.

Principle

The system consists of two units:

- the Gyroscopic Guidance Unit or GGU, containing two compartments, and
- the Fine Guidance Unit, or FGU.

The steering direction to be assumed is fed to a gyroscopic platform in the GGU. When the rocket reaches an altitude of 80 km, the nose cone separates from the propulsion system and the system begins to operate. The gyroscopic platform detects the aiming error and controls (via an electronic computer) the opening and closing of solenoid valves located in the Pneumatic Compartment (PC). These valves admit gas to the exhaust nozzles, allowing motion around the three axes of the nose cone.

Aiming with a precision of 1° is thus assured. The required accuracy (one minute of arc) is then ensured by the FGU, an optical and electronic device, which detects the aiming error by referring to one or two stars selected in advance. These errors are eliminated by activation of the exhaust nozzles.

Utilization

The CASSIOPÉE system can be adapted to any sounding rocket. It can be used in:

- fine uniaxial aiming (stellar, solar, or lunar);
- gyroscopic uniaxial aiming (diurnal or nocturnal);
- fine biaxial aiming (stellar);
- gyroscopic biaxial aiming (diurnal or nocturnal).

(Call-outs on rocket diagram, top to bottom) 4/

Experiment

Fine Guidance Unit (FGU), Stellar

Coarse Guidance Unit (CGU).

Recovery system (optional)

Pneumatic Platform (PP)

Carrier Rocket

Carrier Rocket

Classical Useful Payload with CASSIOPÉE System

(Call-outs on units at right, top to bottom)

Fine Guidance Unit (FGU), Stellar

Coarse Guidance Unit (GGU)

Pneumatic Platform (PP)

Performance and Characteristics of the CASSIOPEE System 5/

Version No. 1 - CGU

It can be used in several versions. In this version, there are two compartments: the gyroscope compartment and the pneumatic compartment.

The system allows biaxial aiming in all directions, with an accuracy of

- 10' for a liquid - fuel rocket,
- 1° for a solid - fuel rocket.

It is possible to achieve 5 successive aimings at intervals selected by the customer, with an adjustable period for each aiming.

It is also possible to achieve all types of scanning at constant or variable speeds, adjustable over a range of 0 to ± 17°/s:

- radial scanning,
- back-and-forth scanning,
- crosswise scanning.

Data corresponding to all aiming and scanning sequences are transmitted to a monitoring station.

The pneumatic compartment can be fitted with 1 to 3 tanks containing:

- 3 kg of nitrogen or neon at 240 bars in the lightweight version, or
- 5 kg of nitrogen or neon at 240 bars in the heavyweight version.

Hence, it is possible to carry out a very complex aiming program after halting an initial rotation that may reach 4 revolutions per second.

Version No. 2: CGU + FGU.

If improved aiming accuracy is desired, a fine guidance unit is added which allows orientation with respect to any celestial target. Several versions are thus possible:

(1) Uniaxial:

Accuracy reaches:

- one minute of arc if the optical systems of the scientific experiment and the sensor are independent,

-thirty seconds if the sensor uses the optics of the scientific experiment.

(2) Biaxial:

The use of two stellar detectors allows any point in the sky to be seen with an accuracy of one minute of arc; the stars which serve as guides are not the same as those under study.

(3) Solar:

If it is desired to study the Sun, regardless of the direction around the latter, it is possible to replace the platform by:

- a rate-gyroscope to measure the rate of roll, and
- a solar detector to measure the aiming errors.

Launching 6/

S.A.G.E.M. and C.d.C. have created a crew of specialists, employed by S.A.G.E.M., whose mission is the preparation of the system both in the assembly room and at the launching site.

This crew is at the disposal of the customer, for setting up and equipping the laboratories required for this effort and attending to all pre-launch operations as well as maintenance. In particular, the crew can furnish the customer with a detailed integration graph of the CASSIOPÉE system.

The cooperation of the S.A.G.E.M. - G3S and C.d.C. groups in building the CASSIOPÉE system allows the most effective means to be placed at the customer's disposal. In effect, the two groups offer considerable potential in the fields of research, study, and construction, as well as lengthy experience and proven competence in all pertinent activities, using the most advanced techniques.